COMPARATIVE ANALYSIS OF COARSE SURFACING AGGREGATE USING THE MICRO-DEVAL, L.A. ABRASION AND SULFATE SOUNDNESS TESTS

MPART Research Proposal

Submitted by:

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1 Problem Statement

The quality of aggregates used to construct pavements must be durable to withstand construction, the environment and traffic. Therefore, choosing tough, long-lasting materials is imperative to pavement performance. Faster construction times have accentuated the need to develop and utilize faster, more accurate methods of testing aggregates. Historically, the Los Angeles (L.A.) Abrasion and Impact tests (AASHTO T 96) have been used to determine the toughness of aggregates. Similarly, the Magnesium and Sodium Sulfate Soundness tests (AASHTO T 104) are commonly used to determine the durability of aggregates. Studies have shown that these tests, however, may not provide an adequate evaluation of aggregates to be used in asphalt pavement construction. Additionally, the Micro-Deval test (AASHTO TP 58-00) offers a significant savings of time and is more repeatable than the L.A. Abrasion and Soundness tests, but to-date, correlations of results between these tests have been mixed.

2 Project Objectives and Benefits

Ensuring that quality aggregates are used in the construction of pavement structures is important. Standard tests are available to determine pertinent strength parameters to ensure that aggregates are both strong and durable. Only limited work has been done to compare the results from other standard tests, such as the L.A. Abrasion and Sulfate Soundness tests. *Therefore, the primary objective of this study is to determine whether the Micro-Deval test can be used to replace the Sulfate Soundness tests.* If successful, the Micro-Deval test will provide a more cost effective and reliable means to characterize the toughness and durability of Montana aggregates.

3 Project Methodology

The toughness and durability of selected aggregates from Montana will be characterized using the L.A. Abrasion, Sulfate Soundness and Micro-Deval tests. Comparisons will be made between the results to determine to the applicability of using the Micro-Deval test procedure to characterize coarse surfacing aggregates in Montana.

The work plan for this project consists of the following tasks, which are described more fully below. These tasks have been designed to address the stated research objectives.

Task 0 – Project Management

Meet with project technical panel to facilitate communication regarding the various aspects of this project. Other communication during the project will be through quarterly progress reports and a final report at the end of the project. A kickoff meeting will held in Bozeman to discuss the project, as well as deliver the Micro-Deval testing apparatus to Montana State University. One additional meeting will occur in Helena near the end of the project to share the final outcome of the research with the technical panel and other interested MDT personnel.

Task 1 – Literature Review

Conduct a literature review to collect and synthesize available published data related to toughness and durability testing of coarse surfacing aggregates. This search will include past as well as current research projects. In addition, the current AASHTO standard for the Micro-Deval (AASHTO TP 58-00) will be reviewed to determine whether revisions are necessary before including it in the "Montana Materials Manual of Test Procedures".

Task 2 – Materials Testing

Perform Micro-Deval and L.A. Abrasion tests on 20 samples of coarse aggregates from multiple, representative geographic locations within Montana. Montana Department of Transportation will conduct Sulfate Soundness tests on the same materials and deliver the results to WTI as the tests are completed. A general sieve analysis will be conducted to characterize each of the 20 materials. Sieve analysis appropriate to the various tests will also be conducted on individual samples tested in the Micro-Deval and L.A. Abrasion apparatuses. Five samples of each material will be tested using each test method, resulting in a total of 200 individual tests (5 samples * 20 materials * 2 test methods). Conducting repeated samples on the same material is necessary to determine statistically-relevant repeatability of the test results.

Task 3 – Analysis and Synthesis of Results

The results from the testing will be compared with one another using statistical methods to determine: 1) repeatability of each of the testing types, and 2) tolerances associated with the Micro-Deval test. Knowing these parameters will help determine whether the Micro-Deval test can replace the Sulfate Soundness test currently being used by MDT. If the results show that the Micro-Deval test can replace the Sulfate Soundness test, then revisions will be made to the "Montana Materials Manual of Test Procedures" to include this test, and if necessary, revise the standard test method to provide more uniform results. The final report will document recommended allowable limits to the specification if MDT chooses to adopt this new test procedure.

Task 4 – Reporting

The study will be concluded with the preparation of a final research report. A draft will be submitted to MDT to allow the technical panel to address any concerns or make suggestions or comments (Task 4a). Comments will be addressed by the research team (Task 4b) and a final report will be submitted by the August 1, 2006 deadline (Task 4c). In addition, progress reports will be submitted on a quarterly basis. A four-page "Project Summary Report" will be written and submitted to MDT near the end of the project to summarize the background, methodology,

results and recommendations of this research. This summary report will be edited, published and distributed by MDT.

Results of the proposed study will be clearly and thoroughly documented in conformance with MDT's standard research report format. Useful conclusions and recommendations applicable to materials testing using Montana soils will be formulated and presented in a clear and concise manner.

4 MDT Responsibilities

Upon the commencement of this project, the Montana Department of Transportation will be responsible for delivering the Micro-Deval device and all associated manuals necessary for its operation to Montana State University. This will be done during the kickoff meeting to be held in Bozeman. MDT, in consultation with WTI, will also be responsible for determining the appropriate sources and quantities of aggregate to be used in this research. MDT will deliver all soil samples to the Western Transportation Institute at MSU. Lastly, MDT will conduct all Sulfate Soundness tests and deliver the results to WTI for inclusion into the analysis and final report for the project.

5 Project Staffing and Administration

Eli Cuelho and Robert Mokwa will be Co-Principal Investigators for this research project. Mr. Cuelho will be the primary manager and the point of contact with MDT. Both P.I.'s will be responsible for ensuring that the objectives of the study are accomplished, implementing the project tasks, and preparing the final report.

Mr. Eli Cuelho – Co-Principal Investigator

Mr. Eli Cuelho is a Research Engineer at the Western Transportation Institute at Montana State University. Mr. Cuelho is a licensed professional engineer in the state of Montana and is currently involved with a number of research projects related to the design and maintenance of transportation infrastructure. He has experience with ITS technology evaluation and deployment, cost-effectiveness and cost-benefit analyses, remote sensing and data acquisition equipment, geotechnical engineering, geosynthetic design, and pavement design and analysis. Two relevant studies conducted by Mr. Cuelho for the Montana Department of Transportation include: *Cost Effectiveness of Crack Sealing Materials and Techniques for Asphalt Pavements* and *A Review of the Performance and Costs of Contemporary Pavement Marking Systems*.

Dr. Robert Mokwa – Co-Principal Investigator

Dr. Robert Mokwa is an Assistant Professor in the Civil Engineering Department at Montana State University. Dr. Mokwa is a licensed professional engineer in the state of Montana with over 15 years of experience covering a broad range of geotechnical, geo-environmental,

transportation, and civil engineering research and design projects. His research skills were recognized by his award of the President's College of Engineering Research Excellence Award from his alma mater, Virginia Tech. He currently teaches classes and conducts research in the area of geotechnical engineering, soil and aggregate materials, frost heave, soil-structure interactions, deep foundations, and site investigative techniques. He has authored numerous technical publications on these topics.

Research Assistants

Mr. Cuelho and Dr. Mokwa will be supported by an undergraduate research assistant, who will work part-time on this project throughout its duration. The student will mainly be in charge of conducting laboratory tests, organizing and analyzing the data, and helping to synthesize the information into the final report. The student will be paid from existing funds at WTI.

6 Project Schedule

The estimated project schedule is depicted in Table 1. The total proposed duration of the project is 12 months, with an estimated start date of September 1, 2005, and an estimated completion date of August 31, 2006.

Table 1: Project Schedule

Work Tasks	Milestone Dates	Q-1, FY-06	Q-2, FY-06			Q-3, FY-06			Q-4, FY-06			Q-1, FY-07	
		Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
Project Start	September 1, 2005	★											
Kickoff Meeting	September, 2005	★											
Final Presentation	August 29, 2006												★
1 – Literature Review													
2 – Materials Testing													
3 – Analysis and Synthesis of Results													
4a – Submit Draft Report	June 16, 2006										★		
4b – Address Comments													
4c – Submit Final Report	August 1, 2006												★

7 Project Budget

The funding request to the Montana Department of Transportation for this proposed research project is $18,082 (costs itemized in Table 2). This amount constitutes 77.5% of the total cost of the project. Matching founds in the amount of $5,242 (22.5% of the total budget) will be provided by the Western Transportation Institute of Montana State University through the MPART agreement. The total estimated cost of the project is $23,323.

In-state travel will cover one trip to MDT for the final presentation for the project. Additional resources (counted as expendable supplies) are needed to cover items such as maintenance on test equipment and materials for preparing and storing soils. Table 3 shows the number of

person-hours that will be devoted to each task by research team members. The total number of person-hours needed to complete the work described in this proposal is 766. Table 4 shows the dollar amounts associated with each task. Benefits are calculated by multiplying the benefit rate for each individual (Eli Cuelho = 31%, Bob Mokwa = 25%, Student = 4%) by their total salary.

Table 2: Research Budget

Item	MDT	WTI Match	Total
Salaries	$ 11,445	$ 4,200	$ 15,645
Benefits	$ 3,323	$ 168	$ 3,491
In-State Travel	$ 150	$ 0	$ 150
Out-of-State Travel	$ 0	$ 0	$ 0
Expendable Supplies	$ 150	$ 0	$ 150
Subcontracts	$ 0	$ 0	$ 0
Direct Costs	$ 15,068	$ 4,368	$ 19,436
Overhead	$ 3,014	$ 874	$ 3,887
Total Project Cost	**$ 18,082**	**$ 5,242**	**$ 23,323**

Table 3: Summary of Person Hours

Tasks	Eli Cuelho (PI)	Bob Mokwa (co-PI)	Student	Totals
0. Project Management	80	20	0	**100**
1. Literature Review	20	10	40	**70**
2. Materials Testing	20	10	240	**270**
3. Analysis and Synthesis of Results	40	20	60	**120**
4. Reporting	105	21	80	**206**
Totals	**265**	**81**	**420**	**766**

Table 4: Summary of Salary and Benefits for Project Team

Tasks	Eli Cuelho (PI)	Bob Mokwa (co-PI)	Student	Totals
0. Project Management	$ 2,321	$ 928	$ 0	$ 3,249
1. Literature Review	$ 580	$ 464	$ 400	$ 1,444
2. Materials Testing	$ 580	$ 464	$ 2,400	$ 3,444
3. Analysis and Synthesis of Results	$ 1,160	$ 928	$ 600	$ 2,688
3. Reporting	$ 3,046	$ 974	$ 800	$ 4,820
Total Salaries	$ 7,687	$ 3,758	$ 4,200	$ 15,645
Total Benefits	$ 2,383	$ 940	$ 168	$ 3,491
Totals	**$ 10,070**	**$ 4,698**	**$ 4,368**	**$ 19,136**